



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear Energy Enabling Technologies (NEET) Advanced Sensors and Instrumentation (ASI)

Suibel Schuppner
Office of Nuclear Energy
U.S. Department of Energy

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Nuclear Energy Enabling Technologies: Advanced Sensors and Instrumentation

■ Vision

Develop advanced sensors and instrumentation technologies that address critical technology gaps for monitoring and controlling advanced reactors and fuel cycle facilities

■ Goal

To provide crosscutting research that:

- **Contributes to the success of the DOE-NE R&D programs**
- **Supports common I&C technology development needs**
- **Overcomes current and future I&C barriers to nuclear energy system deployments**

A new model of I&C innovative RD&D to overcome nuclear power's impediments to new I&C technology usage



ASI Program Areas

NEET Program ...divided into...

Advanced
Sensors and
Instrumentation
(ASI)

R&D Topics ...target gaps in support of...

Advanced
Sensors

Digital Monitoring
and Control

Nuclear Plant
Communication

Advanced
Concepts of
Operation

NE R&D Programs Needs





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NEET- 2 ASI FOA TOPIC: Digital Technology Qualification Demonstration for Embedded Digital Devices

Challenge: Demonstrate that embedded digital devices in NPP components can meet the digital technology qualification requirements

An embedded digital device is an electronic sub-component of a plant component (e.g. instrument or circuit breaker) which uses software or software-developed logic for some aspect of its operation.

The qualification method will demonstrate:

- Cost-effective means of ensuring that the device is not subject to software common cause failure
- Application of these components in a realistic setting representative of actual NPP application

Proposal Requirements:

- **Selected digital equipment shall be for multiple reactors or fuel cycle applications**
 - Applications would include currently-operating LWRs as well as new builds, SMRs, other proven reactor types (e.g., Sodium Fast Reactors or HTGRs), and new reactor concepts, as well as fuel cycle facilities.



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NEET- 2 ASI FOA TOPIC: Digital Technology Qualification Demonstration for Embedded Digital Devices (Cont.)

- Project shall include a nuclear industry partner(s)
 - Team with a **nuclear supplier** that has an embedded digital device in a commercial component to conduct laboratory testing.
 - Team with a **NPP or third-party qualification company** to demonstrate the methodology in an actual qualification task that would meet regulatory requirements.

- Research shall address the following technical challenges:
 - **Proof of acceptable software operational reliability**
 - The NRC has stated that acceptable testing to eliminate consideration of software common cause failure (SCCF) is that “every possible combination of inputs and every possible sequence of device states are tested.”
 - **U.S. NRC regulatory requirements**
 - The methodology will meet regulatory requirements listed in NRC Draft Regulatory Issue Summary (RIS) on embedded digital devices in safety-related equipment (NRC ADAMS Accession No. ML12248A065).



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NEET- 2 ASI FOA TOPIC: Digital Technology Qualification Demonstration for Embedded Digital Devices (Cont.)

- Research shall address the following technical challenges (cont.):
- **Ability to detect defects introduced through the entire supply chain**
 - The methodology will not rely on quality assurance measures prior to the testing, but will be able to detect software defects introduced at any point earlier in the software development process.
 - **Ability to dedicate commercial-grade devices for safety-related usage**
 - The methodology will support typical utility commercial item dedication processes based on 10 CFR 50 Appendix B, 10 CFR 21, Generic Letters 89-02 and 91-05, and EPRI commercial grade dedication guidelines.
 - **Cost-effective and broadly applicable to multiple small plant components**
 - The methodology will not narrowly focus on a single type of digital device but will rather be applicable to a range of device types. It will not be cost-prohibitive to apply this methodology to this range of devices.



Summary of ASI FOA Expectations

- Improvements and advancements in **ASI technologies** will
 - enable advances in nuclear reactor and fuel cycle system development
 - enhance economic competitiveness for nuclear power plants, and
 - promote a high level of nuclear safety.
- Organizations performing this research will be expected to produce concepts, techniques, capabilities, and equipment that are or can be **demonstrated in simulated or laboratory test bed environments** representative of nuclear plant applications.
- Successful applications will describe **truly innovative and crosscutting** sensors and instrumentation that offer the potential for **revolutionary gains** in reactor and fuel cycle performance and that can be applied to **multiple reactor designs and fuel cycle concepts**.

I&C technologies are a vital key to enabling the expansion of clean, safe and economical nuclear power.



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Contact Information

For Questions on NEET-2:

Suibel Schuppner: suibel.schuppner@nuclear.energy.gov

Bruce Hallbert: bruce.hallbert@inl.gov